PHYS 230 HOMEWORK SET 1 SOLUTIONS

CQ1 SINCE $V_{BALLOON} = V_{ROCK}$ ...

a) $F_{B,BALLOON} = F_{B,ROCK}$

b) NOW $V_{BALLOON} = \frac{1}{2} V_{ROCK}$ SO..

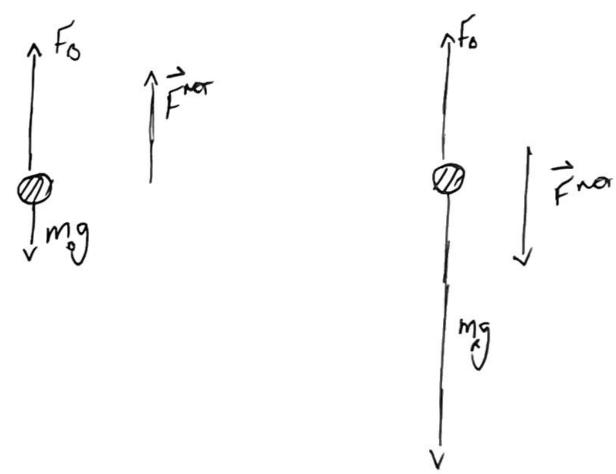
$F_{B,BALLOON} < F_{B,ROCK}$

c) ROCK SINKS, BALLOON FLOATS ..

ALTHOUGH THE BUOYANT FORCE ON BOTH THE ROCK AND THE BALLOON ARE THE SAME, THE NET FORCE IS NOT!

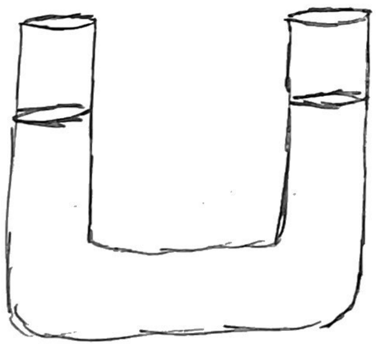
FREE-BODY DIAGRAM FOR...

BALLOON ROCK



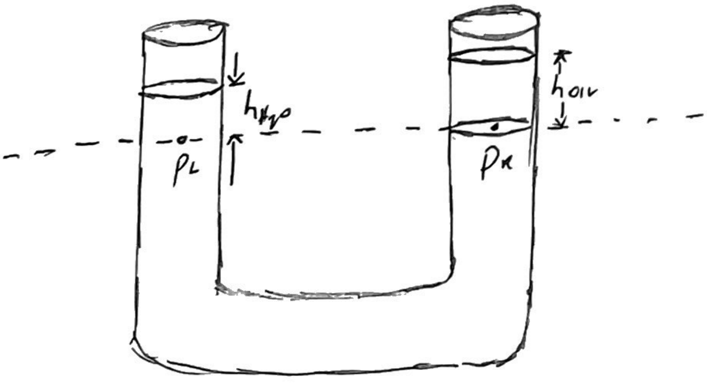
JUST H_2O ...

CQ2



$\rho_{OIL} < \rho_{H_2O}$

ADDING THE OIL..



NOW $P_L = P_R$

$$P_0 + \rho_{H_2O} g A h_{H_2O} = P_0 + \rho_{OIL} g A h_{OIL}$$

SO

$$\rho_{H_2O} h_{H_2O} = \rho_{OIL} h_{OIL}$$

SINCE $\rho_{OIL} < \rho_{H_2O}$

$$[h_{OIL} > h_{H_2O}]$$

NOTICE: THE H_2O LEVEL ROSE IN THE LEFT LEG BUT FELL IN THE RIGHT LEG.

CP3

THE AIR MOVES PAST THE WINDOW AT A HIGH RATE OF SPEED. NOTICE: $V_{INSIDE} = 0$; COMPARE EQUAL HEIGHTS...

$$P_{INSIDE} + \frac{1}{2}\rho V_{INSIDE}^2 + \rho g y_1 = P_{OUTSIDE} + \frac{1}{2}\rho V_{OUTSIDE}^2 + \rho g y_2$$

SINCE $y_1 = y_2$

$$P_{INS} + \frac{1}{2}\rho \cancel{V_{INS}^2}_{\to 0} = P_{OUT} + \frac{1}{2}\rho V_{OUT}^2$$

SO

$$\therefore P_{INS} = P_{OUT} + \frac{1}{2}\rho V_{OUT}^2 > P_{OUT}$$

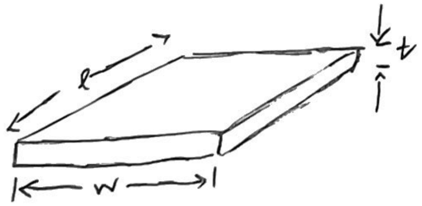
GREATER INSIDE PRESSURE $\therefore$ NET FORCE ON AIR OUT OF WINDOW!

1 $t = 7.0 \times 10^{-3}$ m

$w = 0.21$ m

$l = 0.27$ m

$m = 0.320$ kg



a) $$\rho_{AVE} = \frac{m}{V} = \frac{m}{lwt} = \frac{(0.320\,kg)}{(0.27m)(0.21m)(7.0\times10^{-3}m)}$$

$$\left[\rho_{AVE} = 810\ kg/m^3\right] = 806.25 \approx 806\ kg/m^3$$

b) $$F_{ATM} = p_0 A = p_0 l w$$

$$= (1.01\times10^5 Pa)(0.27m)(0.21m)$$

$$\left[F_{ATM} = 5{,}700N\right] = 5743.71 \approx 5{,}740\ N$$

$$F_g = mg = (0.320kg)(9.8 m/s^2)$$

$$\left[F_g = 3.1N\right] = 3.136N \approx 3.14\ N$$

$$\left[\frac{F_{ATM}}{F_g} = \frac{5700N}{3.1N} = 1800\right] = 1832$$

P2. $M_E = 5.97 \times 10^{24}\,kg$

$R_E = 6.38 \times 10^{6}\,m$

$$\rho_{ave} = \frac{M_E}{V_E} = \frac{M_E}{\frac{4}{3}\pi R_E^3} = \frac{3(5.97\times10^{24}\,kg)}{4\pi(6.38\times10^{6}\,m)^3} = 5{,}490\,kg/m^3$$

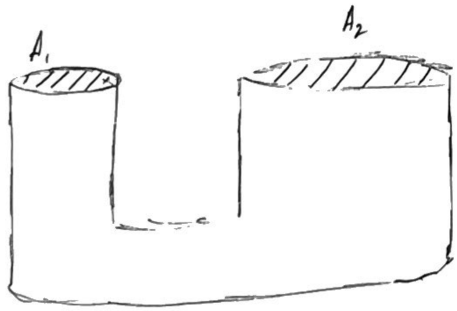
P3 $P_{max} = 1.4 \times 10^{7}\,Pa$

$\rho = 960\,kg/m^3$

$$P_{max} = P_0 + \rho g h \quad so \quad h = \frac{P_{max} - P_0}{\rho g} = \frac{1.4\times10^{7}\,Pa - 1.01\times10^{5}\,Pa}{(960\,kg/m^3)(9.8\,m/s^2)} = 1{,}500\,m$$

$$[h = 1{,}500\,m]$$

P4.



$h = 0$

$R_2 = 1.5\,m$

$F_2 = m_c g = (1200\,kg)(9.8\,m/s^2) = 11{,}760\,N$

$m_p = 65\,kg \quad \therefore \quad F_1 = m_p g = 637\,N$

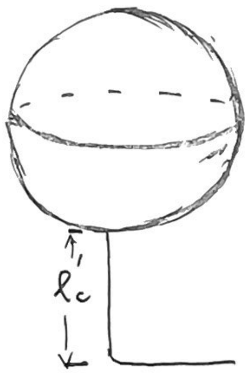
$$P_1 = P_2 \quad \therefore \quad \frac{F_1}{A_1} = \frac{F_2}{A_2} \quad \therefore \quad \frac{F_1}{\pi R_1^2} = \frac{F_2}{\pi R_2^2}$$

$$\therefore R_1^2 = \frac{F_1}{F_2} R_2^2 \quad so$$

$$R_1 = \sqrt{\frac{F_1}{F_2}}\, R_2 = \sqrt{\frac{637\,N}{11{,}760\,N}}\,(1.5\,m)$$

$$[R_1 = 0.35\,m]$$

P5



$l_c' = 8.46 \times 10^{-2}\,m$

$l_c = 100.\,m$

$m_c = 1.85\,kg$

$m_B = 4.55 \times 10^{-3}\,kg$

$\rho_{AIR} = 1.29\,kg/m^3$

$\rho_{He} = 0.179\,kg/m^3$

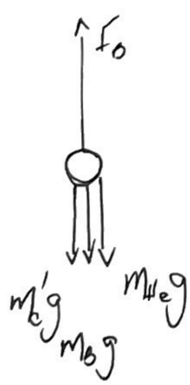
FIRST CALCULATE THE LINEAR MASS DENSITY OF THE CORD...

$$\rho_{CORD} = \frac{m_c}{l_c} = \frac{1.85\,kg}{100.\,m} = 1.85 \times 10^{-2}\,kg/m$$

NOW, CALCULATE THE MASS OF THE SUSPENDED CORD...

$$m_c' = \rho_{CORD}\, l_c' = \left(1.85 \times 10^{-2}\,\frac{kg}{m}\right)\left(8.46 \times 10^{-2}\,m\right) = 1.57 \times 10^{-3}\,kg$$

NOW CONSIDER THE FREE-BODY DIAGRAM FOR THE BALLOON..



$$\sum F_y = 0$$

$$(*)\quad F_B = (m_c' + m_B)g + m_{He}g$$

NOW

$$F_B = \rho_{AIR} V g \quad ; \quad m_{He} = \rho_{He} V$$

SO (*) BECOMES..

$$\rho_{AIR} V g = (m_c' + m_B)g + \rho_{He} V g$$

SOLVING FOR V

$$\rho_{AIR} V - \rho_{He} V = (m_c' + m_B)$$

SO

$$V = \frac{m_c' + m_B}{\rho_{AIR} - \rho_{He}}$$

$$\therefore V = \frac{1.57\times10^{-3}\,kg + 4.55\times10^{-3}\,kg}{1.29\,kg/m^3 - 0.179\,kg/m^3} = \frac{6.12\times10^{-3}\,kg}{1.111\,kg/m^3} = 5.51\times10^{-3}\,m^3$$

$$\boxed{V = 5.51\times10^{-3}\,m^3}$$